



Division of Agricultural Sciences
UNIVERSITY OF CALIFORNIA

CUCUMBER

PRODUCTION

in California

**GLEN N. DAVIS
BERNARR J. HALL**

CALIFORNIA AGRICULTURAL
Experiment Station
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A delicacy rather than a staple, the cucumber has nevertheless held a permanent place in man's diet for several thousand years because of its distinctive texture and flavor. Cucumbers are low in food value, containing about 96 per cent water and providing only 14 calories per 100 grams of edible portion; their nutritive value is slight. And yet they have a long record of popularity. In the Orient they have been cultivated for three or four thousand years. They are mentioned in the Old Testament as a food in ancient Egypt. Migrating farther westward, they were known to the Greeks and Romans, who introduced them into Europe, and they have been grown in America since the earliest settlements.

Today the cucumber is one of California's twenty most important vegetable crops and a popular member of the home vegetable garden as well. In terms of returns to the grower, cucumbers ranked

eighteenth among all vegetable crops in California in 1956, when 6,600 acres planted to this crop had a market value of \$4,824,000. Cucumbers grown for processing accounted for approximately 3,600 acres, with a value of \$1,901,000; the crop from the other 3,000 acres, valued at \$2,923,000, was produced for the fresh market.

Probably originating in India, cucumbers are a warm-season vegetable. Commercial production in California is thus limited to the central and southern areas of the state, and principally to the coastal counties. The greatest concentration is in Alameda County, where more than 50 per cent of the crop for processing is grown. The next largest acreages are found in San Diego, Los Angeles, and Imperial counties, in that order. In other counties the acreage is somewhat limited and varies considerably from year to year.

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JANUARY, 1958

Soil and Climate

Cucumbers will grow on any fertile soil but they must have warm temperatures.

Definitely a warm-season crop, cucumbers are best adapted to an average monthly temperature of 65–75° F, which lasts from 50 to 90 days without extremes of hot or cold. They cannot be hardened to resist even light frosts and cannot be grown unprotected as a winter crop anywhere in the state.

Cucumber seed seldom germinates when the temperature is below 60° F. The optimum temperature for germination is 95° F. Planting should be delayed until conditions are favorable for germination.

Cucumbers grow well on any fertile soil. They have been successfully grown on sandy clay loam, peat, muck, clay, and even somewhat light sands. Where the crops are intended for early market, the lighter soils are preferred. Pickling cucumbers are generally grown on heavier soil types, for in this case earliness is not important. Moisture and plant food supply conducive to large total yield are more generally met on the heavier soils. Very heavy yields of pickling

cucumbers have been secured on peat soils in California.

Since an abundant supply of organic matter is desirable, many states recommend preceding cucumbers with a legume cover crop. The cover crop should be turned under in time for it to decay before the cucumbers are planted. Manure is highly recommended as a source of organic matter.

Cucumbers are sensitive to acid soils. They should be grown in a soil with a pH of 5.5 or higher. Most desirable is a soil with a pH of 6.0 to 6.5.

It is not advisable to replant cucumbers in successive years or to grow them on soil recently planted to any of the other cucurbits, such as watermelons, cantaloupes, or squash, because of possible damage from disease or insects carried over from the old crop. Satisfactory rotation crops are a legume cover crop or other noncucurbit plants, such as beans, celery, or cereals, which will replenish the soil with organic matter.

Varieties

The variety to plant depends first on the use to which the product will be put—fresh market or pickling.

While many varieties of cucumbers are available, relatively few are of commercial importance in California. The variety Marketer is the one most widely grown.

Cucumber varieties are generally more or less arbitrarily lumped into two main

categories—those grown for the fresh market and those grown for pickles. Slicing cucumbers vary in length from 6 to 12 inches and are usually harvested at a more mature stage than those for pickles. Pickling types are picked from
(Continued on page 4)

Some Important Varieties in California

Variety	Spine color	Fruit characteristics			Days from planting to maturity
		Size	Shape	Color	
A & C	White	2-2½" × 8½-10"	Cylindrical; almost round in cross section; slight taper at both ends	Very dark green	66-68
Colorado	White	2-2½" × 8½-10"	Slender cylindrical; slight taper at both ends	Very dark green	66-68
Cubit	White	2-2¼" × 9-9½"	Long, cylindrical; blunt-ended	Very dark green	66
Marketer	White	2¼" × 7½-8"	Cylindrical; slightly tapered ends	Dark green	65
Stays Green	White	2⅜-2¾" × 7-8"	Cylindrical; nearly square ends	Dark green, few thin stripes at tip	59-62
Straight 8	White	2-2¼" × 7½-8½"	Cylindrical; rounded blunt ends	Dark green	64-68
Chicago Pickling	Black	2¼-2⅝" × 6-7"	Cylindrical; square ends; bulging in middle at maturity	Medium green	59-62
Improved Long Green	Black	2½-2¾" × 10-12"	Long, cylindrical; rounded stem end, sharply tapered tip	Dark green, sparse striping at tip	66-69
National Pickling	Black	2-2¼" × 6½"	Cylindrical; very symmetrical with blocky ends	Dark green	54-56
Snow's Perfection Pickling	Black	2½-2¾" × 6-7"	Cylindrical; uniform; distinctly square-ended	Dark green	54-57

PICKLE SIZES

Grade 1

Minimum avg.
2¾" long
⅞" diam.

Grade 2

Minimum avg.
3½" long
1⅞" diam.

Grade 3

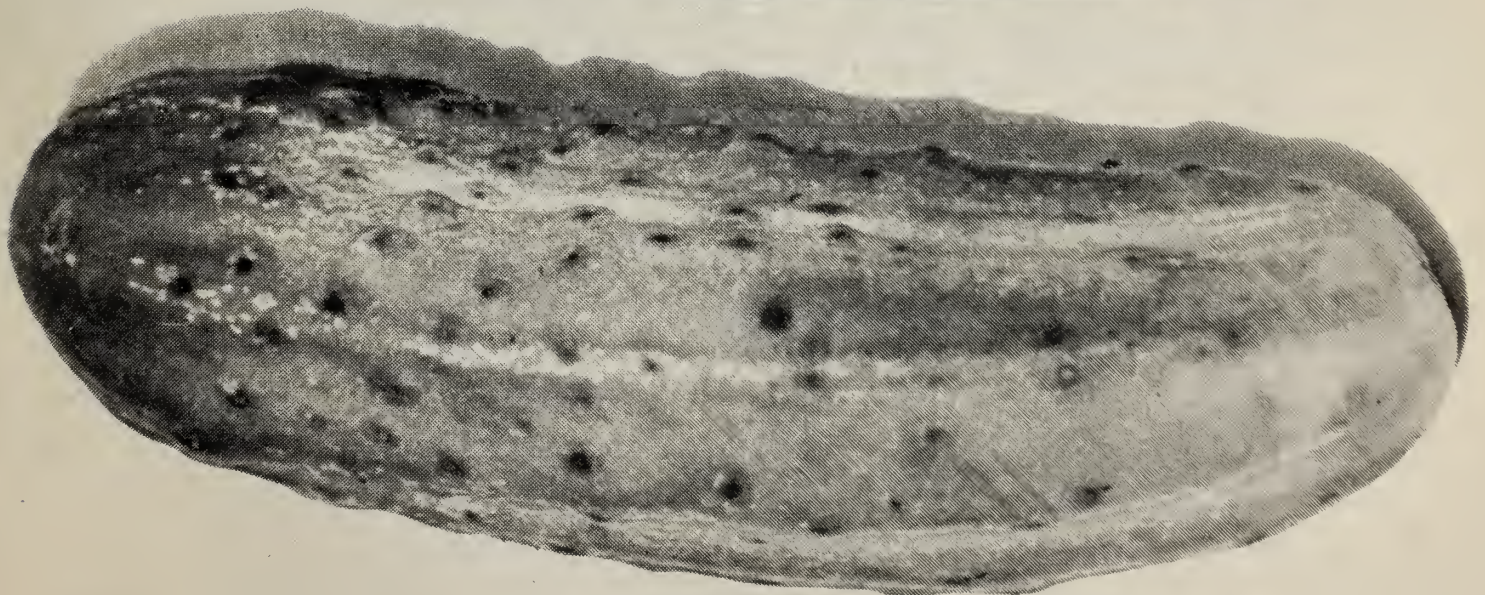
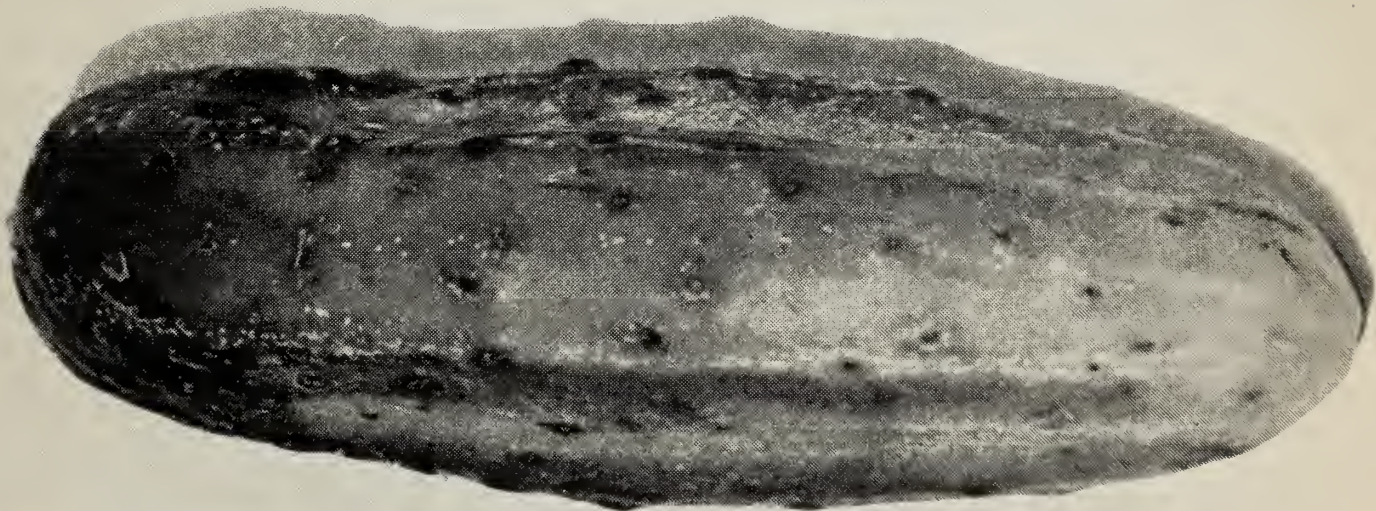
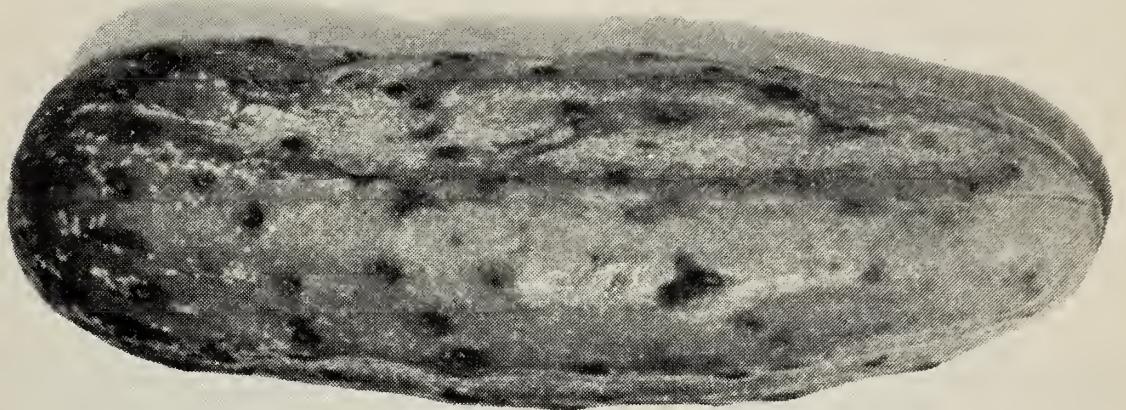
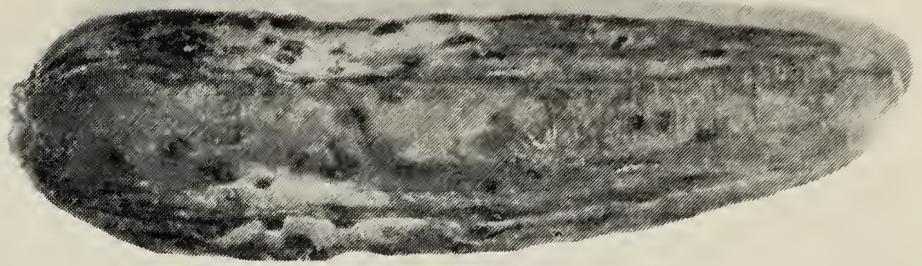
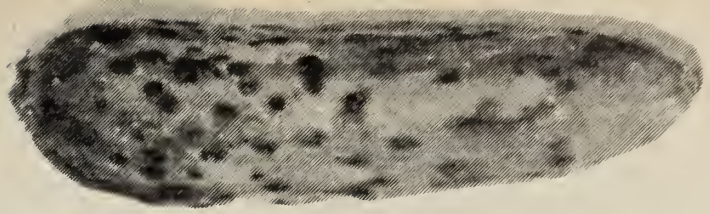
Minimum avg.
4¼" long
1⅜" wide

Grade 4

Minimum avg.
5" long
1¾" wide

Grade 5

Minimum avg.
5¼" long
1⅞" wide



2 to 6 inches long, the smaller sizes usually bringing higher prices.

The more important varieties and some of their characteristics are listed in the accompanying table. The choice of a variety to grow for pickling is often indicated by the processor. If cucumbers are a new crop for you, consult your local Farm Advisor regarding local varietal adaptation and preference.

In addition to the varieties listed in the table, some others may prove desirable under certain conditions. The varieties Santee and Palmetto are resistant to downy mildew, while the varieties Niag-

ara, Wisconsin SMR12, Ohio MR17, Ohio MR25, and York State have considerable resistance to mosaic. A few F₁ hybrid varieties, such as Saladeer and Burpee's Surecrop, are available. These hybrids are resistant to mosaic and downy mildew. The variety Lemon, a small egg-shaped variety, is grown to a limited extent for market and more widely in home gardens.

The West Indian gherkin is grown to a limited extent for pickling. This small, oval-shaped, very spiny fruit belongs to a different species than other cucumber varieties.

Cultural Operations

Growth habits of the cucumber—its root distribution in particular—demand care in cultivation.

Preparing the land

Careful soil preparation is essential to successful cucumber culture. Since the main considerations are earliness, quality, and a fairly long picking season, the soil must be thoroughly prepared, especially where production costs are high.

Land that was in seed or cover crop the preceding season should be plowed during the summer or fall to allow time for decay of the rough material turned under. Land previously planted to alfalfa can be successfully prepared by a shallow (6- to 8-inch) plowing followed by double disking and a deeper (8- to 10-inch) plowing within two or three weeks. Land previously in row crops should be disked and plowed as soon as the crops are harvested.

Final preparation should be made about a month before planting so the soil can settle before the seeds are planted. At this time the land is disked, harrowed,

and leveled or floated. If these operations do not leave a smooth surface of well-pulverized soil, repeat one or more of the operations.

Land prepared according to these directions is ready for planting crops that are to be grown on flat land without irrigation for emergence. If the surface soil is too dry for rapid seed germination and emergence of young plants, irrigation water is applied in furrows adjacent to the planted rows.

If an early crop is to be grown on beds, the preliminary operations are the same as those used for flat land. About a month before planting the land is made into beds 1½ to 2 feet high and 4 to 6 feet from center to center. Where possible the beds should be constructed to extend east and west so that the southern slopes will be exposed to the winter sun. Irrigation water is applied in furrows between the beds.

The beds can be laid out with a lister to which a marker is attached. The lister



PLANTING BY HAND

This is usually done in three short rows that run at right angles to the irrigation furrow.

makes furrows 8 to 10 inches deep, and the beds are formed by back furrowing with a walking plow or with a two-bottom tractor-drawn plow. A heavy tractor pulling six plows can be used to make two half beds in a single operation. The south side of the bed is harrowed and smoothed with a V-drag. The bed is then ready for planting.

Planting

Since cucumbers are susceptible to frost injury, open planting in the field should be delayed until danger of frost

is past. In some areas earlier planting is made possible by using paper covers or caps to protect the young plants; this practice may speed maturity by two to four weeks.

Planting may be done by hand in hills, or the seed may be planted in rows with drills that plant one to several rows at a time. Planting distances vary with the locality. Where the cucumbers are grown in hills, the hills are spaced 2 to 3 feet apart in rows $2\frac{1}{2}$ to 4 or more feet apart. Nine to twelve seeds are planted in each

OR MACHINE

Here cucumber seed is being drilled by a machine that plants three rows at a time.



hill by hand and covered with about 1 to 1½ inches of soil.

When drilled into rows by machine, the seed is spaced thinly and evenly throughout the row. (Rows should be 4 to 6 feet apart.) Two to three pounds of seed should be enough to plant one acre, and care should be taken that the average planter does not drop too much seed.

Thinning

As a rule, cucumbers require thinning. After they have become well established, the stand should be reduced to two to three plants per hill. If they are planted in a continuous row, the final stand should consist of single plants spaced 6 to 12 inches apart. They can be thinned with a hoe along with the first hand weeding. Plants to be removed should not be pulled but cut to avoid disturbing the roots of the remaining plants.

Fertilizers

The kind and quantity of fertilizer needed depend largely on soil type and the amount of available nutrients already in the soil. These characteristics vary with the soil's origin and past history, including its treatment under cultivation.

In California cucumbers often respond to applications of both nitrogen and phosphate fertilizers. Most of the soils in which cucumbers are grown, particularly in the arid interior valleys, are low in organic matter. Manure, if available, is especially desirable; if not, the humus content of the soil can be increased by plowing under alfalfa, clover, vetch, cowpea, soybean, sesbania, cereal, and other soil-improving crops.

Nitrogen. In the Imperial Valley and southern districts 60 to 75 pounds per acre of nitrogen should be applied, while as much as 100 pounds or more per acre may be needed for growing the pickling crop in central California. Half the amount can be applied at planting, the remainder when the runners start. Dry fertilizer can be applied with a fertilizer

drill a few inches to the side of and a few inches below the seed. Equivalent amounts of liquid fertilizer containing nitrogen can be added to the irrigation water. If heavy nitrogenous fertilizers have been applied to the preceding crop, cucumbers may not need additional nitrogen.

Phosphate applications should be made early—preferably at, or shortly after, planting. Amounts of fertilizer that deliver 60 to 100 pounds of phosphate expressed as phosphoric acid (P_2O_5) per acre should be applied. About 600 pounds per acre of a single superphosphate (16 to 20 per cent P_2O_5) or proportionately less of the more concentrated forms can be broadcast before bedding the soil. Phosphate fertilizers can also be banded into the beds just before planting—a few inches to the side of and a few inches below the seed, between the seed row and the irrigation furrow.

Equivalent amounts of liquid phosphate fertilizer can be banded into the soil with special equipment, or they can be given in the irrigation water at planting or even earlier. If liquid fertilizer is used, the irrigation water must be carefully controlled to obtain uniform distribution and to prevent excessive loss of fertilizer in the waste water. Phosphate fertilizer may not be needed if it has been used on the preceding crop.

Fertilizers such as 11-48-0 or 16-20-0, which contain both nitrogen and phosphorus, can be used to supply all or part of the nitrogen and phosphorus requirement. Experiences to date have not indicated a response to the addition of potash.

Cultivation and weed control

Cucumbers should be cultivated from the time the plants break through the ground to keep the soil loose and free from weeds until the spread of the vines makes further working impracticable. Early cultivation may be fairly close to

the plants and at reasonable depths. After the roots begin to spread, the later, shallow cultivations should be farther away from the plants.

A comparatively shallow-rooted plant, the cucumber has roots that often extend beyond the tips of the vines. Therefore, after the vines begin to run freely, cultivation should be relatively shallow and not too close to the rows. Hand hoeing will generally be necessary early in the season when the plants are small. After the vines cover the ground no further cultivation can be given, but it is often necessary to go through the field and pull out weeds that are gaining a foothold.

Weed control in cucumber fields may prove costly, especially if weeds in preceding crops are allowed to mature and go to seed. Competitive weed growth should be reduced while the cucumber plants are small, and the field should be kept free from weeds until harvest is finished.

Besides being highly competitive, certain weeds may harbor virus diseases and insect pests, thus serving as reservoirs of infection in the current crop.

The use of chemicals for weed control in the cucumber crop is showing promise. One method, perhaps the more economical one, is to spray the plant row after seeding and before either the weed or cucumber seed germinates. Weeds between the rows may be easily removed by cultivation. Chemical herbicides can also be applied to the ridged bed and ditch

after the final furrow and bed are made, just ahead of first picking. This eliminates hand weeding in the plant zone and irrigation furrow.

Two selective chemicals that show promise in controlling weeds in cucumber fields are N-1 naphthyl-phthalamide acid and sodium isopropyl xanthate. Dosages may vary slightly depending on the amount of moisture following the application, soil type, kind of weeds, and cucumber variety tolerance.

Before applying a herbicide consult your county Farm Advisor for information on local experiences and recommendations.

Irrigation

For maximum yields and high quality, cucumbers must have an adequate supply of moisture. In irrigation as in weeding, the plant's moderately shallow root distribution must be borne in mind. The roots extend to a depth of only about 4 feet if no hardpan prevents root penetration to this depth.

If the soil is filled to its maximum water-holding capacity before planting, by winter rainfall or preirrigation, additional water at fairly frequent intervals is essential for maximum production. Generally, 18 to 24 inches of water is applied during the growing season.

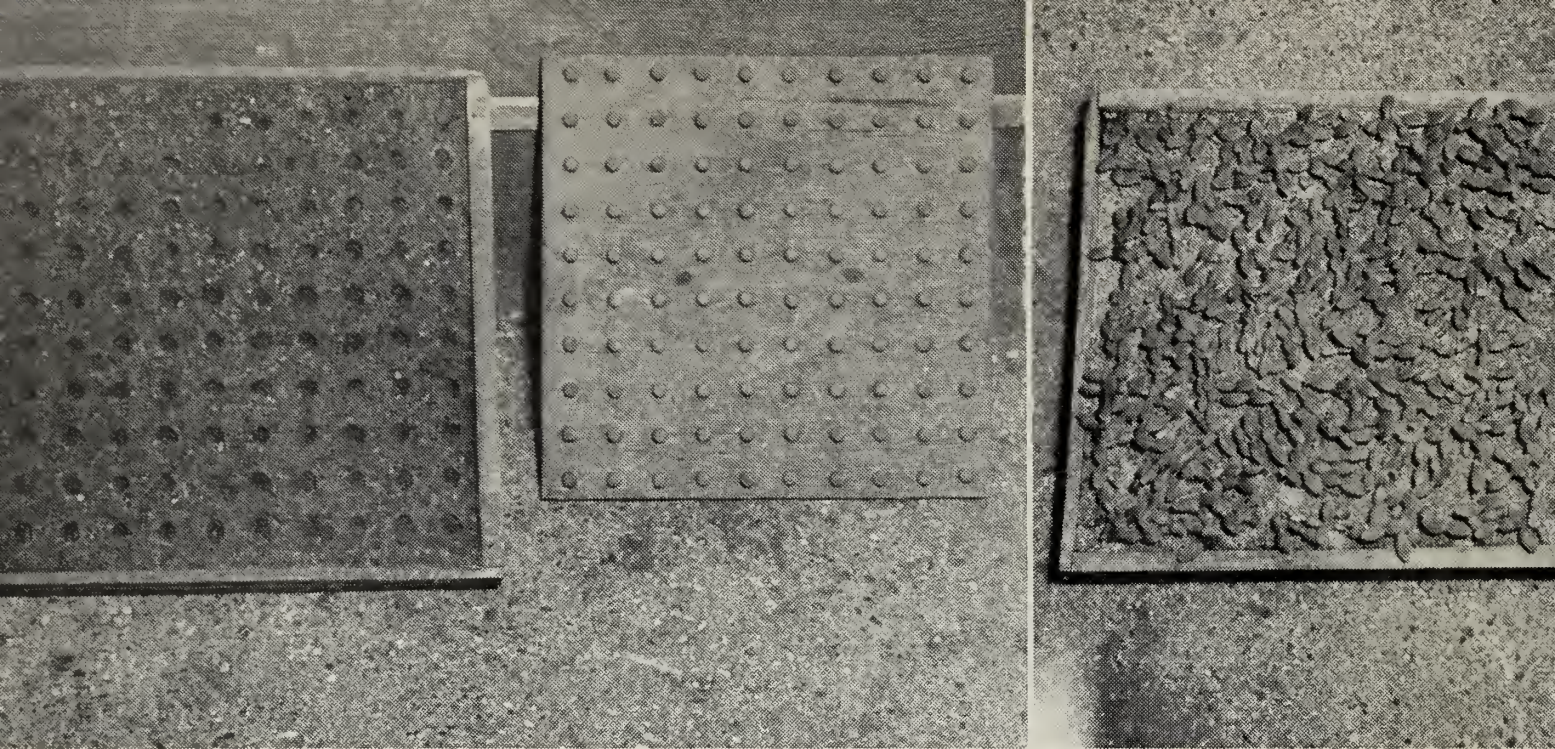
Furrow irrigation is the most common method, although where the water supply is limited or costs are exceedingly high, sprinklers may be used.

Early Market Cucumbers

Need special planting methods and care during early growth.

Producing early spring cucumbers requires many special and varied operations. Because of the plants' temperature

requirements, production is limited to southern California. The early planting may be made with transplants started in



PLANT IN FLATS

The planting board makes 100 marks in each flat—four or five seeds are placed in each mark. Photo left center shows sprouted

flats in the greenhouse, by direct seeding in the field, or by both methods.

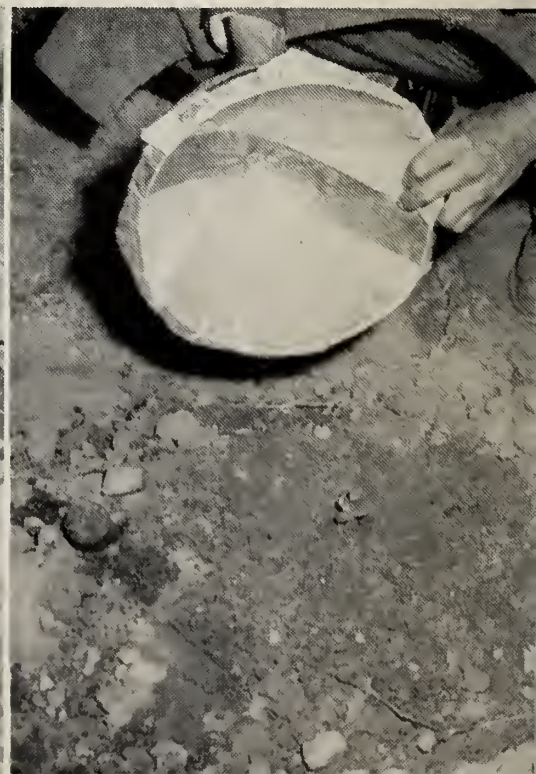
Transplants. Cucumber plants for transplanting to the field are usually started in flats in the greenhouse in January and February. The soil in the flat is marked with a pegged planting board (100 pegs per flat), and four or five seeds are planted in each mark. This gives 100 clumps of four or five plants per flat. It takes five to six days from time of planting seed to transplanting into the field. At this time the clumps are removed and set into place with a plant setter.

Direct seeding. In the field, seed is planted in shallow depressions (often finger marks), which are parallel to, or at right angles to, the side of the irrigation furrow. The right-angle position insures that some seeds will get enough moisture for germination if there is a variation in the way the water soaks into the furrow. Twelve to 20 seeds are planted in each hill.

Combination planting. To insure a good plant stand, some growers set out transplants and plant seed in a single operation.

THEN TO FIELD

To insure a good stand, some growers set out transplants and then plant seeds in the same hill. Transplants should be covered with





plants in a flat next to a newly planted flat that has half of the seeds covered. Photo at right shows plants being transplanted from flats to the field using a plant setter.

For early market cucumbers, regardless of the planting method, at planting time the hills are enclosed with hot caps to protect the transplants or germinating seedlings from frost and to speed their growth. To obtain a satisfactory stand, two to four replantings with transplants or seed are often necessary. At each inspection for plant stand and replanting, the weeds are removed before the caps are replaced over the hills.

As the plants develop and become crowded in the original small cap, the small caps are removed and replaced

with larger tent caps. This change is usually made in late March, and at the same time the plants are thinned to two or three per hill and the weeds are removed from the area to be covered. The larger cover allows a larger area to be covered, resulting in more rapid plant growth. About the middle of April when the plants have filled the tents, the leeward end of the tents is unfolded. During this operation the area is again weeded, and the plant runners are gently guided out of the open end of the tent. As the plants develop and enlarge in the open-

hot caps until they are big enough to require more room. Then the hot caps may be removed and larger tent caps used in their place.



ing, the caps are lifted, permitting the plants to become acclimated as they grow out from under the tents. When the plants have runners 18 to 24 inches long, the tent covers are finally removed.

In controlling pests while the plants

are small, dusts are applied to the plants when the covers are opened, or application may be made with a puff duster equipped with a small, short metal nozzle which is forced under the cap before delivering the dust.

Pollination

Cucumber fruit set is particularly dependent on bees.

Two kinds of flowers are borne on every cucumber plant—the male flowers, which supply the pollen, and the female ones, which produce the cucumbers. The two types of blossoms can be readily distinguished, as the female flower is on the outer end of the little cucumber.

In general, male flowers appear in great abundance in advance of the female flowers. This often leads to the erroneous notion that the cucumbers are failing to set fruit. Later the female flowers appear and the fruit is formed.

In cool weather the ratio of male to

female flowers is usually quite high. As the temperature rises, more female flowers are produced and the ratio is more nearly even, although there are always several times as many male as female flowers.

Pollination, which results in the setting of fruit on cucumber vines, is dependent particularly on bees. Without proper pollination the cucumbers are deformed, or at least a high percentage of nubbins may be produced. In localities where bees are scarce it is advisable to place a few stands of bees in or near the field.

Diseases

How to recognize and control the diseases most common to cucumbers in California.

Powdery mildew

Powdery mildew occasionally causes damage to cucumbers. The disease is recognized by the presence of the fungus *Erysiphe cichoracearum* upon the leaves. Tiny patches of white growth first appear on the stems and older leaves, particularly at the crown of the plant. Although they are more numerous on the shaded

portions of the stems and the undersides of the basal leaves, they soon appear on both surfaces of leaves and on all parts of the plant. The spots enlarge and coalesce, covering the affected areas with a powdery growth. Affected leaves turn yellowish-green or yellow, later wilting, drying, and falling off. Severely diseased plants die prematurely.

The organism overwinters on melon vines and other cucurbits that are grown throughout the winter months in the warmer regions.

A 1 per cent Karathane dust, applied at the rate of 40 pounds per acre at 10-day to 2-week intervals, has given good control of this disease.

Southern blight

This disease is caused by the soil-borne fungus *Sclerotium rolfii*. The occurrence and destructiveness of this disease are variable and sporadic, depending principally on weather conditions and previous cropping history. It is most damaging under warm temperature conditions in fields where very susceptible crops, such as sugar beets, have been severely attacked.

Southern blight is usually first detected as a wilting of the growing tip during the middle of the day. In more advanced cases the whole plant wilts and dies because the stem tissue has rotted at the ground line. When such a plant is found wilted in the field, it is well to examine the main root near the soil surface. There the fungus causing the death of the plant can be readily seen and identified by the presence of white mycelium and the small, brown sclerotia, which look like mustard seed, clustered on the stem at the soil line. The sclerotia are scattered when the soil is tilled, and they are also distributed by running water. They germinate in a moist atmosphere and infect other plants. Cucumbers should not follow crops that have been infected by the fungus.

Angular leafspot

This disease may cause damage to cucumbers growing in humid areas. In California, therefore, it is important only in the coastal areas, and it is most likely to cause severe damage if plants are sprinkler-irrigated.

The first symptoms on leaves, stems,

and fruits are small, water-soaked spots that later may become covered with a gummy or shiny bacterial exudate. The spots in the leaves become tan or brown; they are angular because the infected areas are delimited by veins.

The bacterium (*Pseudomonas lachrymans*) that causes this disease is seed-borne and persists on infected crop refuse. It is spread by water and infects through stomata.

The use of clean seed, grown in arid regions where the disease is not likely to occur, and rotation to avoid fields that contain infected debris from a previous crop are effective methods of control.

Cottony leak

The fungus species, *Pythium* and *Phytophthora*, that cause this disease are soil inhabitants. The disease causes greatest damage in wet soils. The fungi are propagated by mycelium and by spores that move about in water. The fungus is spread by contact and can apparently penetrate the fruits without the aid of visible wounds. Plants or fruits that come in contact with infected soil or irrigation water, or that become spattered with wet soil containing spores or mycelium, may become infected.

THESE TERMS MAY BE UNFAMILIAR TO YOU:

The mass of interwoven threads of the fungus composing the **mycelium** often has a cobwebby or cottony appearance.

The **sclerotium** is a compacted mass of mycelium. The sclerotium of some fungi is crustlike; others form sclerotia that look like seed.

The **stomata** of leaves are microscopic openings, most abundant on the underside, through which the plant may be said to "breathe."

Infection takes place in the field, although decay may not develop until the cucumbers are in transit when it may spread very rapidly. During excessively wet seasons the fungus may also cause damping-off and vine canker.

The first symptoms on the fruits are soft, dark-green, water-soaked lesions; later, as the mycelium penetrates the tissues of the fruit, water is liberated in large quantities. In the moderately humid atmosphere of containers during transit, a very luxuriant, white, cottony mycelium is produced, which sometimes completely covers the fruit. When juice from decaying cucumbers leaks down on those below, the mycelium becomes flattened and forms a matted layer on the surface of the fruits. Unless other contaminating organisms are present, the cucumbers will decay completely without disagreeable odor.

This disease may be controlled in ordinary seasons by providing good drainage and by thinning out the plants. Cucumbers showing any evidence of decay at time of harvest should not be shipped.

UP-TO-DATE CONTROL MEASURES

At the time this manual went to press, the recommendations given here for the control of both diseases and insect pests were the most satisfactory that had been developed. These measures may continue to be the most effective for some time; however, chemical advances in this field are being made so rapidly that improved materials or methods might soon be available. To take advantage of the latest developments and give your crop the best possible protection, consult your local University of California Farm Advisor before planning your program of disease and pest control.

Damping-off

Damping-off of cucumber seedlings is characterized by a shriveling and water-soaking of stems at the ground line that cause a sudden collapse and death of the young plants. In many cases it is often responsible for poor stands. This trouble may be caused by several fungi that are common in the soil and are most severe during periods of cool, wet weather.

Damping-off can usually be satisfactorily controlled by treating the seed with Spergon or Arasan. Spergon should be used at the rate of $\frac{1}{3}$ teaspoon of dust per pound of seed or 4 ounces per 100 pounds of seed. The recommended rate for Arasan is $\frac{1}{4}$ teaspoon per pound or 2 ounces per 100 pounds of seed.

Mosaic

Cucumbers are susceptible to several viruses, but the most prevalent and damaging virus disease is mosaic, which is caused by various strains of cucumber mosaic virus 1. This virus is world-wide in distribution and also infects many other cultivated crops and weeds.

The symptoms in cucumber are quite variable because of the many strains of the virus, but the usual symptoms are stunting of the plant accompanied by mottling, cupping, and distortion of the leaves. Fruits produced on infected plants often show knotty or warty islands of green on an otherwise white background, a symptom that has been called "white pickle."

The cucumber mosaic virus is transmitted from plant to plant by several species of aphids. The virus overwinters in winter-hardy host plants, such as spinach, celery, and beets, or in several susceptible weed hosts. These infected plants are fed upon by aphids that later feed on healthy cucumber plants, thus introducing the virus into the new crop. Similarly, these insects spread the virus from plant to plant during the growing season.

The most promising method of control is the development of resistant varieties.

Insect Pests

Those to watch for are described below with suggested control measures.

Cucumbers are often attacked by insects or other related pests at practically every stage of growth. For this reason it is necessary for growers to control one or more of these pests in most of the growing areas of California.

Pest control should ordinarily begin with treatment of the seed before planting, and it may continue to harvest time depending upon the severity of the pests in different areas and their abundance at particular times of the year.

Seed-corn maggot

The white, wedge-shaped, legless larvae of this fly, *Hylemya cilicrura* (Rond.), often attack the germinating seeds and young seedlings, causing death or disfigurement of the plants. Attacks are more prevalent in early plantings when germination is retarded and the soil is moist. Disking under green crops or excessive amounts of organic materials tends to increase the maggot population. The adult flies select newly cultivated soil in which to deposit their eggs.

Seed treatment before planting is usually quite effective in reducing damage. One ounce of actual lindane, heptachlor, aldrin, or dieldrin, combined with an adequate fungicide, is enough to treat 100 pounds of seed. The fungicide should *always* be applied simultaneously with the insecticide. Insecticides are best applied to the seeds as slurries rather than dusts, as dusts often come off in subsequent handling of the seed. Wettable powders containing 50 to 75 per cent active insecticides are available. Seeds should be treated as close to planting as possible in order to reduce possible damage from long storage periods.

Wireworms

Wireworms, the active, feeding larvae of click beetles, bore into germinating seeds and young seedlings. They are commonly $\frac{1}{2}$ to 1 inch long, elongate, smooth, and glossy brown. Many species of click beetles spend several years in the soil as wireworms before changing into adults. Our economic species belong to the irrigated-land wireworms of the genus *Limonius*.

Control can be accomplished in two ways: 1) soil treatment before planting; 2) seed treatment at time of planting. For soil treatment the following materials can be used: DDT, 10–20 pounds actual per acre; aldrin and heptachlor, 3–5 pounds actual per acre; chlordane, 8–10 pounds actual per acre. These chemicals are sprayed or dusted on the surface of the soil and disked to a depth of 6 inches the same day they are applied. DDT should be applied at least three months ahead of planting; the other chemicals can ordinarily be applied just ahead of planting as they kill worms more rapidly. The higher rates are suggested for heavy soils.

Seed treatment with the materials listed for the seed-corn maggot is usually satisfactory.

Cucumber beetles

Cucumber beetles are often important pests of cucumbers and other cucurbits. The important species are the western spotted cucumber beetle, *Diabrotica undeimpunctata* Mann., and the western striped cucumber beetle, *Acalymma trivittata* (Mann.). In southern California *Diabrotica balteata* Lec. and *D. undeimpunctata howardi* Barber also occur.



PESTS

Left: the striped cucumber beetle and (center) the spotted cucumber beetle may cause damage or even kill plants. The squash bug (shown at right) only occasionally attacks

The adult beetles are yellowish to yellowish-green with black spots or stripes and are $\frac{1}{5}$ to $\frac{1}{4}$ inch long. They lay their eggs in the ground about the bases of the plants. Here the eggs hatch into larvae which feed on the roots and underground portions of the stems. The white to tanish larvae attain a length of $\frac{1}{2}$ to $\frac{3}{4}$ inch. A conspicuous brown anal plate, a dark head, and a dark shield just behind the head distinguish them from other larvae found about cucumber roots.

The winter is spent in the adult stage, and about three generations occur a year. Damage is twofold. Adults feed on the foliage and stems of the young plants, and on the foliage, flower structures, and fruit of the larger plants. Damage may result in stunted or deformed plants, scarred fruits, or the death of small plants. Damage is also caused by larvae feeding on the underground portions of the plants; this often results in wilting, lack of fruit set, or the death of small plants.

Several insecticide dusts can be applied to the plants when excessive numbers of beetles appear:

DDT, 5 per cent dust at 20 pounds per

acre. Do not use more than this, and do not use within three weeks of harvest. Tolerance 7 ppm (parts per million).

Methoxychlor, 5 per cent dust at 30 pounds per acre. Can be used up to seven days of harvest. Tolerance 14 ppm.

Cryolite, 40 per cent dust at 30 pounds per acre. Do not use within four weeks of harvest, or remove excessive residues by washing or brushing. Tolerance 7 ppm (fluorine).

Parathion, 2 per cent dust at 30 pounds per acre. Apply up to two weeks before harvest. Tolerance 1 ppm.

Malathion, 5 per cent dust, at 20 to 30 pounds per acre. Apply to within three days of harvest. Tolerance 8 ppm.

Melon Aphid

The melon aphid, *Aphis gossypii* Glover, is the most common aphid on cucumber and may cause severe damage. This yellowish-to-greenish or greenish-black aphid is $\frac{1}{16}$ inch long. It prefers the undersides of the leaves where it is found in colonies.

Aphids spend the winter on a number of available hosts and in the spring fly to the young cucumbers, giving birth to



cucumbers—it prefers squash and pumpkins and rarely requires control in cucumbers.

living young. The sexual stage is not always needed, and colonies develop very rapidly.

Melon aphids suck the cell sap and cause distorting, stunting, and leaf curling in addition to spreading cucumber mosaics. They also secrete honeydew, which enables a sooty mold to develop.

Chemical control is often necessary, although ladybird beetles and syrphid fly larvae often assist greatly in reducing the aphid population. Materials such as DDT may increase the aphid problem, so populations must be carefully watched. The following chemicals can be applied for aphid control:

Parathion, 2 per cent dust at 30 pounds per acre. (In San Diego County, however, a 1 per cent dust at the same rate has been found effective.) Apply to within two weeks of harvest. Tolerance 1 ppm.

Malathion, 5 per cent dust at 20 to 30 pounds per acre. Apply to within three days of harvest. Tolerance 8 ppm.

Nicotine, 3.6 per cent nicotine alkaloid, 30 to 35 pounds per acre. Apply to within one week of harvest. Tolerance 2 ppm.

TEPP, 1 per cent dust, 20 to 30 pounds per acre. Apply to within three days of harvest. Tolerance 0 ppm.

Spider mites

Spider mites, *Tetranychus* spp., often damage cucumbers. These small, eight-legged pests are only $\frac{1}{50}$ inch long, but they can pierce the cells on the underside of the leaves with their stylet-like mouthparts, causing the foliage to yellow. They also web the leaves. Defoliation and loss of fruit may result.

CAUTIONS ON INSECTICIDES

The enactment of recent legislation dealing with residues of agricultural pesticides allowable in raw agricultural products makes it necessary for growers to apply to cucumbers only chemicals for which established tolerances have been set. For this reason, check with your local agricultural authorities to see that your insect control program does not constitute a violation of the present law. For certain hazardous materials, at certain levels, it is necessary to post fields with "poison out" signs and obtain permits to conform to state and local laws.

Most insecticides are poisonous and should be stored out of reach of children, irresponsible persons, or livestock. Empty containers should be burned or buried. Certain chemicals, especially phosphates, such as parathion, are particularly hazardous to the operator; protective clothing should be worn and equipment used as specified by the manufacturer. All precautions, safety rules, and rates of application given on the label should be carefully followed.

Although sulfur is commonly applied to cucumbers in coastal areas without injury, its use as a carrier in insecticide formulations in the hotter interior localities should be restricted, as foliage or fruit burn may occur.

When mites appear, any of the following materials can be applied:

Parathion, 2 per cent dust at 30 pounds per acre. Apply up to 15 days of harvest. Tolerance 1 ppm.

Aramite, 3 per cent dust at 20–35 pounds per acre. Apply to within 15 days of harvest. Tolerance 1 ppm.

Malathion, 5 per cent dust at 20–35 pounds per acre. Apply to within three days of harvest. Tolerance 8 ppm.

Root-knot nematode

These minute eelworms or nematodes, *Meloidogyne* spp., cause swellings or galls on the roots of cucumbers and many other plants. Aboveground effects are general lack of vigor, dwarfing of plants, and wilting in the middle of the day.

Fumigating the soil before planting will usually control nematodes during the subsequent crop. D-D mixture and EDB (ethylene dibromide) are the two fumigants commonly used. Fumigants can be applied to the entire area, drilled in at 12-inch intervals by special equipment, or applied as row treatments in the area to be planted. For full coverage use 20 gallons (200 pounds) of D-D per acre at 12-inch spacings, or 3 to 4 gallons of actual EDB per acre. With 24-inch spacings, use 13½ gallons (135 pounds) of D-D or 2.5 gallons actual EDB.

An interval of 12 to 18 days should be

allowed between treatment and planting depending on soil type, moisture, and climatic conditions. If a strong odor of fumigant persists, do not plant until the odor is reduced.

Occasional pests

The leafhopper, *Empoasca filamenta* Delong, may become abundant enough to cause a yellow spotting of the leaves. Control is the same as for cucumber beetles.

The **squash bug** prefers squash and pumpkins, and it attacks cucumber only occasionally. Control is seldom necessary.

Thrips of several species may cause characteristic silvering of the young plants and sometimes deformation of the leaves. The plants usually grow out of the injury. If control is necessary, use the same materials given for cucumber beetles or melon aphid.

Darkling ground beetles of the genus *Blapstinus* may cut off the small plants by feeding on the stems near the ground. Control is with DDT or other materials listed under cucumber beetles.

Leaf miners of the genus *Liriomyza* may mine the leaves, causing characteristic serpentine tunnels. Control is usually not needed; if necessary, leaf miners can be controlled by one to three applications of 2 per cent parathion dust.

Harvesting and Packing

Picking and packing require considerable hand labor even when mechanical harvesting equipment is used.

Harvesting

Cucumbers should be picked at frequent intervals to avoid losses due to oversize and overmature fruits. The fields are generally picked at 2- to 4-day intervals depending on the weather. Dark

green fruits 5 to 8 inches long and 1½ to 2 inches in diameter are the desired sizes for the fresh market.

Cucumbers should be removed from the vines by turning the fruit parallel to the vine and giving it a quick snap. This



HAND PICKING

This may be done into buckets (as shown) or into baskets. Pickers empty their containers into bags or boxes at the ends of rows.

prevents vine damage and results in a clean break of the stem. At each picking, culls and fruits that are odd-shaped or overmature are removed to insure continued production of desired types. The culls are usually left in the field between the rows.

The standard lug box is the container most commonly used in picking cucumbers for fresh market. Wire carriers are fastened on the ends of the boxes to facilitate handling. Bushel baskets with wire or cloth-padded handles are also used. Pickling varieties are often picked directly into burlap sacks, or the fruit may be picked into metal buckets and then emptied into sacks before being taken to the processing plants.

Although cucumbers must be hand-picked, a machine that will carry ten or twelve pickers over as many rows has been developed and is becoming popular.

Lying across the long carrier, the pickers remove cucumbers of the desired sizes and place them on a conveyor belt that carries them to burlap sacks in a common grain-sacker arrangement. The machine cuts harvesting costs in half compared with the lug- or pail-picking method. It may increase yields 10 or 15 per cent over other picking methods. In addition, use of the machine results in less damage from trampling of the vines and thus prolongs the life of the plants.

At the closer spacings two rows are generally trained together and can be harvested by one picker. At the wider row spacings only limited vine training is necessary, and one picker harvests a single row. Cloth or rubber gloves are often worn by the pickers to avoid hand injury from the spiny leaves, stems, and fruits.



MACHINE PICKING

COMING

Two views of the same machine. Here the cucumbers are delivered to sacks on the rear of the machine. A worker standing in the back removes obviously bad pickles as they travel up the ramp.



and GOING



IN BOXES

This machine delivers the cucumbers into big boxes, supplies of which are kept at either end of the field.



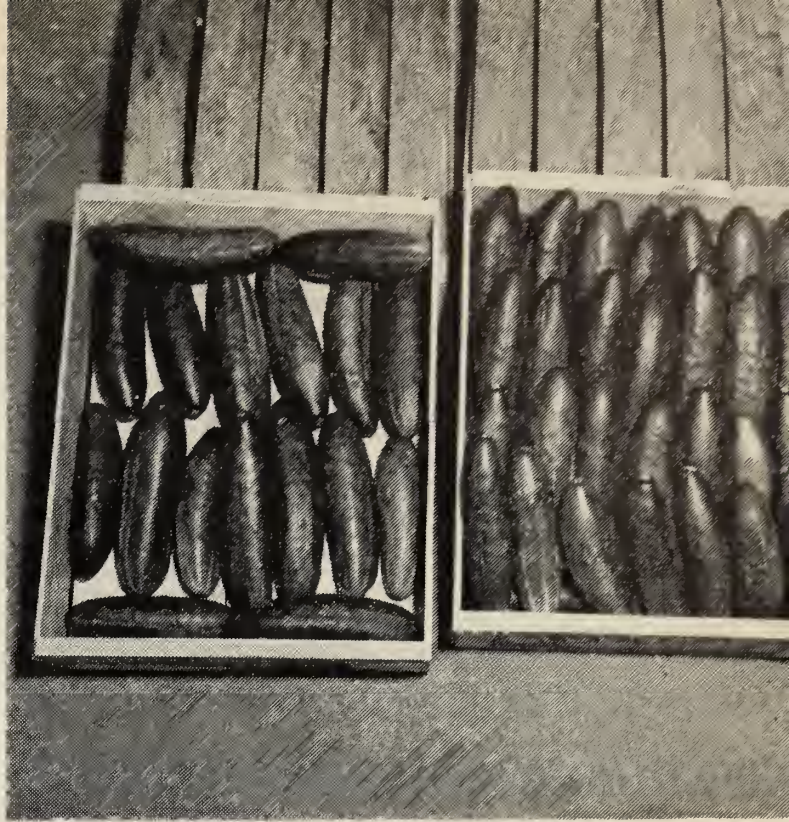
The boxes are made so that they can be handled by a fork lift for ease in getting them aboard a truck and to the collecting point.

Packing

After picking, the cucumbers are transported to a field or central packing shed. Here trained workers wash, sort, and pack the fruits according to size and grade. When the fruits are washed, wax is often applied to improve appearance and keeping quality.

The lug box is the container most commonly used to pack and ship cucumbers to market. A small lug box, called a flat, is also used. For a fancy pack, especially early in the season, a shallow box holding a single layer of fruit may be used. In this type of container 25 to 28 medium-sized fancy cucumbers are packed at an angle. The two-layer flat is also often used.

Burlap sacks are usually used to transport pickling cucumbers from the field to the processing plant where they are generally graded according to size.



FRESH MARKET

Here are two commonly used packs for cucumbers sold in the fresh market.

GRADING PICKLES

This machine sorts pickles into grade sizes through different sized mesh, delivers them into boxes on both sides.



Storage and transit

Since cucumbers are a warm-season vegetable crop and are not frost-hardy, they are subject to physiological injury when exposed to temperatures below 50° F for prolonged periods. This response is referred to as chilling injury or low-temperature injury.

Symptoms of chilling injury are sunken circular pits which may coalesce to form irregular sunken areas on the surface of the fruit, resulting in unsightly appearance and increased susceptibility to decay. At temperatures below 50° F fruit is subject to injury both in storage and in transit, the degree of injury depending on the temperature and the length of the storage period. Injury may or may not be apparent at the time of removal from storage, and the length of time the cucumbers are held after they have been removed from storage influences symptom development.

Suitable temperatures for storage, handling, and transit depend on the duration of storage and the use to be made of the product. If cucumbers are held no longer than two days, temperature has little practical effect. For longer periods in transcontinental shipment or in warehouse storage, temperatures should be kept near 50° F to prevent breakdown from chilling during subsequent marketing. If the cucumbers are to be used immediately after removal from storage and the holding period does not exceed 16 days, temperatures somewhat below

50° F seem to have little practical injurious effect. For maximum storage life, however, cucumbers should be held at or near 50° F, even though they are to be consumed immediately upon removal from storage.

PRODUCTION COSTS

The cucumber is one of the more expensive crops to grow and harvest. Many factors contribute to high production costs: the high cost of good soil in frost-free areas; preparation of the land, including fumigation, fertilizers, growing and putting out transplants, hand planting, replanting, double capping, frequent weeding, and irrigation; frequent picking; the number of containers needed to handle the bulky fruits; and packing.

Actual costs of growing and harvesting a cucumber crop vary from locality to locality depending on local practices and the purpose for which the crop is grown. No single estimate of costs would be applicable to every grower. However, the summary of cost studies presented in the accompanying table will indicate the items that must be considered and the relative costs for materials and the different operations.

Some Figures on the Cost of Producing Cucumbers for Market and Processing in San Diego County*

	Market				Summer processing crop	
	Early spring crop		Summer and fall crop			
	17½ tons		17½ tons		15.6 tons	
	Cost per acre	Cost per 100 lbs.	Cost per acre	Cost per 100 lbs.	Cost per acre	Cost per 100 lbs.
Land preparation: plow, disk, level, fumigate..	\$ 20.00	\$ 0.06	\$ 46.28	\$ 0.14	\$ 12.25	\$ 0.04
Planting.....	81.00	0.23	9.10	0.03	2.33	0.01
Cultural labor.....	221.00	0.63	136.17	0.40	92.10	0.30
Harvest, packing.....	385.00	1.10	327.74	0.95	347.43	1.11
Cost of materials.....	732.50	2.09	411.34	1.19	123.97	0.40
Cash overhead.....	99.99	0.28	82.37	0.24	42.60	0.14
Land cost.....	42.00	0.12	49.40	0.14	40.00	0.13
Total costs †.....	\$1,581.49	\$ 4.51	\$1,062.40	\$ 3.09	\$ 660.68	\$ 2.13

*Based on survey records from 11 growers in San Diego County.
†Amounts in breakdown are given in round numbers.

Production was fairly steady in California from 1952–1956

Crop	Year	Acreage harvested	Average yield per acre*	Total production	Unit price	Total value
		acres			dollars	dollars
For pickles	1952	3,570	8.4 tons	30,000 tons	52.05	1,562,000
	1953	4,000	8.6 tons	34,560 tons	52.10	1,800,000
	1954	3,100	9.5 tons	29,470 tons	45.85	1,351,000
	1955	3,100	341 bu.	1,057,000 bu.	1.30	1,374,000
	1956	3,600	406 bu.	1,462,000 bu.	1.30	1,901,000
Early market	1952	1,500	420 bu.	630,000 bu.	2.10	1,323,000
	1953	1,400	390 bu.	546,000 bu.	2.90	1,583,000
	1954	1,600	420 bu.	672,000 bu.	2.00	1,344,000
	1955	1,500	185 cwt.	278,000 cwt.	4.00	1,374,000
	1956	1,500	185 cwt.	278,000 cwt.	4.75	1,901,000
Late market	1952	1,200	370 bu.	444,000 bu.	1.50	666,000
	1953	1,700	330 bu.	561,000 bu.	1.45	813,000
	1954	1,500	350 bu.	525,000 bu.	1.95	1,024,000
	1955	1,500	185 cwt.	278,000 cwt.	3.80	1,056,000
	1956	1,500	175 cwt.	262,000 cwt.	3.90	1,022,000

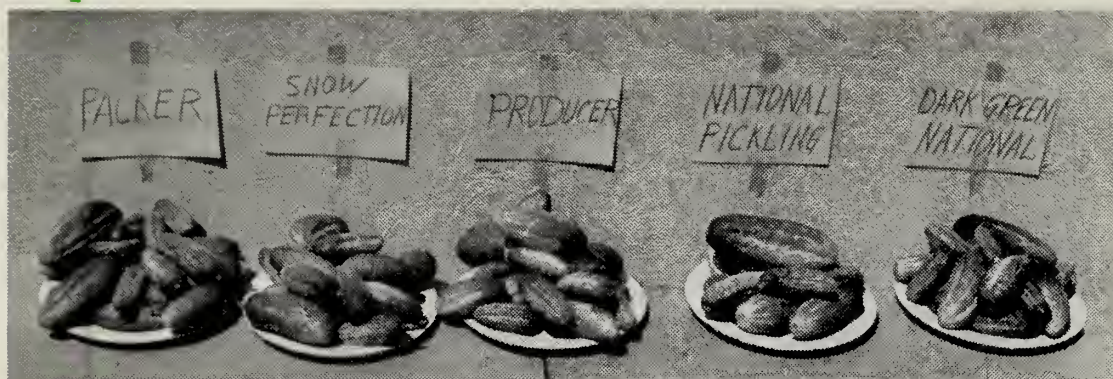
* The weight of a bushel of cucumbers is 48 lbs.

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COMPETITION...

of a sort

You may never see these cucumbers at a State or County fair. But by careful testing, analyzing, comparing of varieties, scientists from the Agricultural Experiment Station and Extension Service are gaining and distributing information valuable to farmers and processors. The photo above shows results of some field tests on cucumber varieties.

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